CORE
Metadata, citation and similar papers at core.ac.uk
Provided by Sebelas Maret Institutional Repository

Pengujian Karakteristik Perpindahan Panas dan Faktor Gesekan Pada Penukar Kalor Pipa Konsentrik Dengan Double Sided Delta-Winglet Tape Insert

Adi Eka Pranata
Jurusan Teknik Mesin
Fakultas Teknik Universitas Sebelas Maret
Surakarta, Indonesia
Email : pranata.ekaadi@gmail.com

Abstrak

Penelitian ini menguji pengaruh penambahan *double-sided delta-winglet tape insert* (DWTs) variasi sudut serang (α) dan *winglet-width ratio* (R_B) di pipa dalam dari penukar kalor pipa konsentrik terhadap karakteristik perpindahan panas dan faktor gesekannya. Pada penelitian ini DWTs divariasi pada α = 30°, 50°, dan 70°, dan R_B = 0,28; 0,35; dan 0,42. Sebagai perbandingan, pada penelitian ini juga dilakukan pengujian pada penukar kalor tanpa sisipan (*plain tube*). Fluida kerja yang digunakan adalah air panas di pipa dalam dan air dingin pada *annulus* dengan sistem aliran berlawanan arah. Pengujian dilakukan pada kisaran bilangan Reynolds 5.500 - 14.500. Hasil pengujian menunjukkan adanya peningkatan bilangan Nusselt (Nu), faktor gesekan (*f*) dan unjuk kerja termal (η) dibandingkan dengan *plain tube*. Karakteristik bilangan Nusselt (Nu), faktor gesekan (*f*) dan unjuk kerja termal (η) dengan penambahan sisipan DWTs meningkat dengan kenaikan sudut serang (α) dan nilai *winglet-width ratio* (R_B). Penukar kalor dengan penambahan sisipan DWTs dengan α = 70° dan nilai R_B = 0,42 menghasilkan bilangan Nusselt, penurunan tekanan, faktor gesekan, effektivenes dan unjuk kerja termal tertinggi. Pada kisaran 5.500 - 14.500 nilai Nu_i pipa dalam dengan penambahan DWTs dengan α = 30^o, 50^o dan 70^o berturut- turut meningkat dalam kisaran 110% - 131%, 157% - 188% dan 218% - 264% dibandingkan dengan Nu_i *plain tube*. Sedangkan pada penambahan DWTs variasi R_B = 0,28; 0,35 dan 0,42, Nu_i meningkat berturut- turut dalam kisaran 214,4% - 268,4%; 271,3% - 318,2% dan 341,1% - 364,3% dibandingkan dengan Nu_i *plain tube*. Pada kisaran 5500 - 14.500 nilai faktor gesekan rata-rata di pipa dalam dengan penambahan sisipan DWTs variasi α = 30^o, 50^o dan 70^o berturut-turut sebesar 8,8; 10,2 dan 11,1 kali faktor gesekan *plain tube*. Sedangkan dengan penambahan sisipan DWTs variasi R_B = 0,28; 0,35 dan 0,42 berturut-turut sebesar 11,8; 13,4 dan 15,5 kali faktor gesekan *plain tube*. Nilai unjuk kerja termal penukar kalor dengan penambahan sisipan DWTs dengan sudut serang 30^o, 50^o dan 70^o berturut-turut dalam kisaran 0,91 – 0,99; 0,92 – 1,11 dan 0,91 – 1,22. Sedangkan nilai unjuk kerja termal penukar kalor dengan penambahan sisipan DWTs variasi R_B = 0,28; 0,35 dan 0,42 berturut-turut dalam kisaran 0,91 – 1,22; 0,96 – 1,30 dan 1,01 – 1,39.

Kata kunci : bilangan Nusselt, *double-sided delta-winglet tape insert*, faktor gesekan, sudut serang, *winglet-width ratio*

Investigation on Heat Transfer and Friction Factor Characteristics in A Concentric Tube Heat Exchanger Equipped With The Double Sided Delta Wing Tape Insert

Adi Eka Pranata
Mechanical Engineering Departement
Engineering Faculty Sebelas Maret University
Surakarta, Indonesia
Email : pranata.ekaadi@gmail.com

Abstract

This study was conducted to examine the effect of angle of attack (α) and winglet-width ratio (R_B) on the characteristics of heat transfer and friction factor in a concentric tube heat exchanger equipped with the double-sided delta-winglet tape insert (DWTs). In this study, angle of attack (α) was varied by 30^o, 50^o and 70^o, while the *winglet-width ratio* (R_B) varied by 0.28, 0.35 and 0.42. For comparison, in this study also tested heat exchanger without insert (plain tube). The working fluid in the inner tube was hot water and in the annulus was cold water, with the flows direction were counterflow. Tests were conducted at a Reynolds number (Re) 5500 - 14,500. The study results showed that the use of DWTs, increasing the Nusselt number (Nu), friction factor (*f*) and thermal performance (η) as compared with the plain tube. Characteristics of heat transfer, friction factor and thermal performance of the heat exchanger with the use of DWTs increased with the increase in α and R_B. The heat exchanger with the addition of the DWTs with α = 70° dan value of R_B = 0.42 produced the highest Nusselt number, pressure drop, friction factor, effectiveness and the thermal performance. In the range of 5500 - 14,500, the value of Nu_i in the inner tube with the addition of DWTs with α = 30^o, 50^o and 70^o increased in the range of 110% - 131%, 157% - 188% and 218% - 264% compared with the Nu_i of plain tube, respectively. While the addition of DWTs with R_B = 0.28, 0.35 and 0.42, increased in the range of 214.4% - 268.4%, 271.3% - 318.2% and 341.1% - 364.3% compared with the Nu_i of plain tube, respectively. In the range of 5500 - 14,500 value of the average friction factor in the inner tube with the addition DWTs with α = 30^o, 50^o and 70^o increased 8.8, 10.2 and 11.1 times than the friction factor of plain tube, respectively. Meanwhile, with the addition of inserts DWTs with R_B = 0.28, 0.35 and 0.42 increased 11.8, 13.4 and 15.5 times than the friction factor of plain tube. Thermal performance of the heat exchanger with the addition of DWTs with α = 30^o, 50^o and 70^o in the range of 0.91 – 0.99, 0.92 – 1.11 and 0.91 – 1.22, respectively. While the thermal performance of the heat exchanger with the addition of DWTs with R_B = 0.28, 0.35 and 0.42 in the range of 0.91 – 1.22, 0.96 – 1.30 and 1.01 – 1.39, respectively.

Keywords : angle of attack, double-sided delta-winglet tape insert, friction factor, Nusselt number, winglet-width ratio